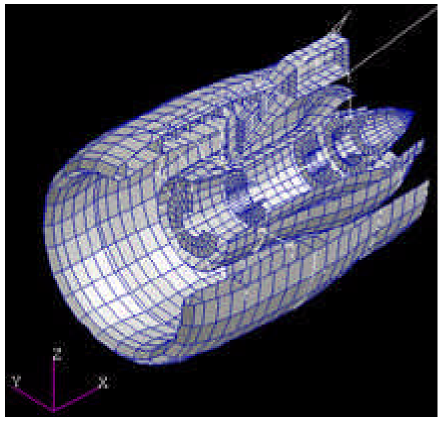
Structural Simulations of Engine-Airframe Systems Being Improved

The current environment for designing engine and engine-airframe structural systems requires extensive efforts to prepare and integrate models, generate analysis results, and postprocess data. Despite these efforts, the accuracy of the simulations is inadequate, leading to less than optimal designs, costly testing and redesigns, and most important, significant uncertainties in safety factors. The goal of this project is to develop improved tools for structural simulations of engine-airframe systems. To develop these new tools, the NASA Glenn Research Center at Lewis Field has teamed with GE Aircraft Engines, Pratt & Whitney, and Boeing Commercial Aircraft. Boeing brings a wealth of large-scale, complex, structural systems analysis experiences and capabilities to the team, while GE and Pratt & Whitney bring aircraft-engine-specific structural expertise.

The tools that the team is creating are being used to assess a multitude of structurally related problems. The primary problem being addressed is the accurate simulation of a blade-out event and the subsequent windmilling of the engine. Reliable simulations of the loss of a blade are required to ensure structural integrity during flight as well as to guarantee successful blade-out certification testing. Simulation of the windmilling that occurs after blade-out is critical to avoiding excessive vibration levels, which may damage the aircraft and endanger passengers. In addition to blade-out and windmilling, the structural simulation tools are being used to determine structural response during regular aircraft operations and under loadings resulting from flight maneuvers. The loads generated by these analyses are critical for the teams designing several airplane components, including the engine, nacelle, strut, and wing.

The approach being used for the system simulation is to first develop a detailed high-fidelity simulation to capture the structural loads resulting from blade loss, and then use these loads in an overall system model that includes complete structural models of both the engines and airframe. The detailed simulation includes the time-dependent trajectory of the lost blade and its interactions with the containment structure, whereas the system simulation includes the lost blade loadings and the interactions between the rotating turbomachinery and the remainder of the aircraft’s structural components. General-purpose finite-element structural analysis codes are being used to accomplish this task, and provisions are being added to include transient effects from the blade loss and rotational effects resulting from the engine’s turbomachinery. The figure depicts the generic structural model that was constructed to demonstrate and validate the tools that are being developed under this project.



Engine-wing structural system model.

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